Metropolitan Networks Based on Fiber and Free Space Access Distribution System

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Field of the Invention

[01] The present invention relates to local access broadband metropolitan switching and routing methodologies and distribution architectures encompassing the combination of fiber, free space optical communications (FSOC) and radio (or wireless) techniques.

Background of the Invention

[02] Free Space Optical Communications (FSOC) and millimeter wave radio technologies are a relatively new but potentially critical access technologies for broadband last mile access for building-to-building, LAN, metropolitan and ultimately residential neighborhood distribution. Market estimates predict the FSOC industry alone will be a $3 billion market by 2005.

[03] FSOC technologies have been utilized for stadium, campus and building-to-building and private network applications since the late 1980's. Only recently have technologies, market demand and broadband access issues converged to migrate this technology toward mainstream telecommunications and local access network distribution applications. AT&T and other vendors desiring to enter local access markets but with no heritage equipment or infrastructure to do so may take advantage of this technology.

[04] The creation or re-creation of existing metallic access infrastructure across the country to support traditional "wired" broadband access services would prove both very expensive and limiting in the long term for service providers in their

efforts to bring broadband services to the customer. Hence AT&T's ongoing efforts in the cable industry and legal challenges for access rights to the existing local exchange carrier (LEC) infrastructure. These traditional metallic and newer cable and DSL deployment strategies may gain moderate bandwidth to AT&T's customers near term, but the existing metallic infrastructure will ultimately not support the surge in consumer bandwidth demand expected over the next ten years. Clearly an alternative technology and infrastructure solution are needed that can be created and deployed in parallel to the existing infrastructure but capable of handling the bandwidth expectation of the near future access networks.

[05] The obvious answer to the near future bandwidth demand challenge is the ubiquitous deployment of fiber optics access networks and fiber-to-the-curb/fiber-to-the-home (FTTC/ FTTH). But like other cabled technologies, fiber must be physically laid or hung between connecting nodes, the issues of trenching, rights of way and costs of fiber deployment and vulnerability, itself have significantly delayed earlier optimistic plans for wide scale fiber deployment and are likely to slow deployment even more as increasing cost overheads erode the fiber access business plans and amortization over a customer base. This leaves no clear or easy fiber-to-customer based solution.

[06] Point-to-point wireless is an attractive intermediate broadband alternative to widespread fiber based broadband deployment. Millimeter wave radio can provide moderate bandwidth (OC3-12) over short distances, is rapidly and easily deployed/installed, without the need for physical connectivity to the customer or other issues associated with rights of way. On the down side millimeter wave radio, is a shared medium and subject to regulatory and spectrum license control. Further, millimeter wave radio is a line-of-sight system and subject to weather related limitations. Channel reuse is limited thereby suppressing the scalability of a radio access deployment within a residential or metropolitan customer base.

Summary of the Invention

[07] Alternatively, FSOC is an optical fiber-like service. FSOC technology is also a "through-the-air" point-to-point deployment architecture and similar to millimeter wave wireless local multipoint Distribution System (LMDS) in its ease of installation and deployment. FSOC is also similarly limited by climatic conditions, but is critically, free of government regulatory and spectrum licensing. FSOC operates at optical wavelengths and frequencies that can provide enormous bandwidth per wavelength and utilize multiple wavelengths within the bundled beams transmission path, including single, multiple "coarse" WDM and dense wavelength division multiplexing (DWDM) applications. Most significantly FSOC is a means to provide smooth low cost deployment and distribution of these wavelengths to individual customers and ultimately the smooth deployment of wavelength-based packet-switching without the considerable cost and deployment restrictions of fiber and the restrictive spectrum and licensing costs of millimeter wave radio.

[08] It is becoming increasingly clear that metropolitan optical networks will consist of a blend of fiber and optical/radio wireless distribution architectures. This blend of broadband access technologies is driven primarily by the increasing cost, deployment delays and restrictions on fiber deployment and city trenching. These broadband technology blends will likely be coupled into locally intelligent routing configurations via statistically placed switching and routing aggregation nodes. These nodes will themselves couple transparently to the core/long haul network and form the fabric of an all optical broadband communications structure reaching to and from the customer "first mile/last mile" access domain through the core optical network to its target local access destination. The distribution nature of free space, fiber or millimeter wave radio coupled with the unique and flexible switching/routing architecture of these aggregation nodes, and an operational description of these nodes and their capability to switch single/multiple wavelengths, lambda or packet-switching based (or some blend thereof), is the subject described herein. The invention also provides a flexible transport